INDOOR AIR QUALITY ASSESSMENT

Milford District Court
161 West Street
Milford, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
February 2008

Background/Introduction

At the request of Michael Norman, Building Systems Manager, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality at the Milford District Court (MDC), 161 West Street, Milford, Massachusetts. The request was prompted by concerns related to acute reports of respiratory irritation by occupants.

As described by Mr. Norman, maintenance department members, security personnel and other general court staff, on January 16, 2008 at approximately 11:00-11:30 AM several occupants experienced acute symptoms of respiratory irritation near the security checkpoint in the main lobby. Reportedly, no odor was detected and there were no particular activities (e.g., construction, cleaning) reported/observed inside or outside the court facility that would provide a possible source of the irritant. As a result, the Milford Fire Department (MFD) was contacted, the building was evacuated, mechanical ventilation systems were shut down and windows were open to ventilate the building. According to the incident report, the MFD arrived on-scene at 12:02 PM. No release of hazardous materials was found, nor was lingering health effects/injuries reported. The building was cleared for reoccupation by 12:23 PM (MFD, 2008).

The BEH's Indoor Air Quality Program was contacted on the afternoon of January 17, 2008 and asked to provide technical assistance. On January 18, 2008, a visit to conduct an indoor air quality assessment was made to the MDC by Cory Holmes an Environmental Analyst in BEH's Indoor Air Quality (IAQ) Program. The investigation focused on identification of potential irritants (see Investigation of Potential Irritants). In addition, a general assessment was conducted to evaluate the heating, ventilating, and air-conditioning (HVAC) system and other

factors that can affect IAQ. Mr. Holmes was accompanied by MDC maintenance staff and Mr. Norman during the assessment.

The MDC is a two-story brick and concrete building that was constructed in the late 1960s. The building underwent renovations in 2001, which included a new roof and interior modifications. The main (front) entrance opens to a lobby where occupants are directed up a staircase to the second floor security checkpoint area. Also located on the second floor are two main court rooms, judge's lobbies', storage and office space. The first floor contains the juvenile court, office space, the maintenance department, storage and mechanical rooms.

Methods

BEH staff performed a visual inspection for potential sources of respiratory irritants as well as any pathways that could provide a means of migration of such irritants into occupied areas. General indoor air quality tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

The MDC has an employee population of approximately 40, and can be visited by up to 150 visitors on a daily basis. Tests were taken under normal operating conditions and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in 19 of 29 areas surveyed, indicating inadequate air exchange in these areas during the assessment. These measurements were likely due to the deactivation of mechanical ventilation components. It is important to note that several areas where carbon dioxide levels were below 800 ppm were empty or sparsely occupied at the time of the assessment, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to be higher with increased occupancy.

Mechanical ventilation in the court rooms, main lobby/security checkpoint area and interior rooms is provided by air-handling units (AHUs) located either on the roof (Picture 1) or in the first floor mechanical room (Picture 2). Conditioned air is distributed via slotted or multi-directional air diffusers (Pictures 3 through 6) and ducted back to AHUs via return vents (Pictures 7 and 8). As previously mentioned, the mechanical systems were deactivated; therefore there was no means of mechanical air exchange during the assessment, as evidenced by elevated carbon dioxide levels (e.g. 3,041 ppm in courtroom #1). Without proper supply and exhaust ventilation, normally occurring environmental pollutants can build up indoors and lead to IAQ/comfort complaints. The system was subsequently reactivated by MDC maintenance staff, which reduced the carbon dioxide level substantially (1,360 ppm/Table 1).

Fresh air in office areas is provided by (univent) systems (Pictures 9 and 10). A univent draws air from outdoors through a fresh air intake located on the exterior wall of the building (Picture 11) and returns air through an air intake located at the base of the unit (Picture 12). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air

diffuser located in the top of the unit (Figure 1). Univents have control settings of off, low, med or high (Picture 13). The majority of univents were found deactivated; therefore, there was no means for providing mechanical ventilation in these areas at the time of the assessment. Univents are reportedly original equipment (40+ years old). Efficient function of such aged equipment is difficult to maintain, since compatible replacement parts are often unavailable. Univents were also found obstructed by furniture and other items, which can limit airflow. In order for univents to provide fresh air as designed, intakes/returns must remain free of obstructions. Importantly, these units must remain "on" and be allowed to operate while rooms are occupied.

Airflow is also limited by the univent/thermostat controls. Univents at the MDC do not run continuously but are activated by thermostats (Picture 14). Univents are activated once room temperatures drop below a level set. When the room temperature exceeds the thermostat setting, the univent is deactivated or cycles off, which prevents continuous air circulation and filtration.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems reportedly occurred in 2002.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied.

Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult Appendix A.

Temperature measurements the day of the assessment ranged from 66^{o} F to 76^{o} F, which were within or close to the lower end of the MDPH recommended comfort range. The lobby was 66^{o} F due to the continuous opening and closing of exterior doors. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, it is difficult to control temperature and maintain comfort with old

equipment and/or without operating ventilation continuously while the building is occupied (e.g., univents cycling/AHUs deactivated).

Although temperature control complaints were not expressed in the juvenile court, the potential exists. BEH staff observed a photocopier located directly beneath the thermostat (Picture 15). During summer months, heated air rising from the photocopier would activate the thermostat, which would in turn activate the HVAC system to provide cold air to this area. In winter, the HVAC system would be deactivated by heated air from the laser printer interacting with the sensors in the thermostat.

The relative humidity ranged from 13 to 57 percent, which was below the MDPH recommended comfort range in the majority of areas surveyed during the assessment. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. It is important to note however, that relative humidity measured in courtroom #1 was significantly higher than other interior areas (Table 1). This increase in relative humidity indicates that moisture removal (e.g., water vapor from occupant respiration) is not adequate when HVAC system is deactivated. Moisture removal is important since the sensation of heat conditions increase as relative humidity increases (the relationship between temperature and relative humidity is called the heat index).

As indoor temperatures rise, the increase of relative humidity will make occupants feel hotter. If moisture is removed, the comfort of the individuals is increased. Relative humidity would be expected to drop below comfort levels during the heating season. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

In order for building materials to support mold growth, a source of water exposure is necessary. Identification and elimination of the source of water moistening building materials is necessary to control mold growth. Water-damaged wall plaster and efflorescence (e.g., mineral deposits) was observed in April's office/D.A. area (Picture 16). As moisture penetrates and works its way through mortar around brick it leaves behind these characteristic mineral deposits. BEH staff conducted moisture testing to determine if the material was wet. Materials with increased moisture content *over normal* concentrations may indicate the possible presence of mold growth. The water-damaged wall plaster tested during the assessment was found to have low (i.e., normal) moisture content. Moisture content of materials measured is a real-time measurement of the conditions present at the time of the assessment.

Water-damaged ceiling tiles were observed in the Juvenile Court Magistrate's office (Picture 17), which can indicate leaks from the plumbing/HVAC system. Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed/discarded.

Plants were observed in several areas. Plants should be properly maintained and equipped with drip pans. Plants should be located away from ventilation sources (e.g., univents)

to prevent aerosolization of dirt, pollen or mold. Plants should not be placed on porous materials (Picture 18), since water damage to porous materials may lead to microbial growth.

Investigation for Potential Irritants

The reported symptoms originated in the main lobby/security checkpoint area with a rapid onset of irritant symptoms in several occupants. Upon evacuation and ventilation of the building with use of openable windows, occupant symptoms quickly dissipated (~ 15 minutes). No similar symptoms have reoccurred since the initial incident in any location within the MDC. The MDC has reportedly not had any previous history of such incidents or symptoms. In addition, no pattern related to outdoor weather conditions, time of day/week or particular indoor activities can be identified that may have created conditions that led to this incident. The rapid onset of symptoms, localization of event (in the main lobby/security checkpoint area), rapid resolution of symptoms and lack of reoccurrence of symptoms tend to indicate a possible release/discharge of an irritant in the lobby (e.g., pepper spray).

There were no odors detected nor were there symptoms reported by building staff the day of the BEH assessment. During the assessment, BEH staff focused on identifying potential sources and/or pathways for irritants to enter occupied areas throughout the building. BEH staff could not identify any sources of irritants during this assessment. A number of pathways exist for air to travel into the lobby, primarily via the supply and return vents connected to the mechanical ventilation system (Pictures 1 and 2). The AHU for this area is located on the roof (Picture 1). Due to the location of the AHU fresh air intakes on the roof (i.e., two-story high/center of building) and restriction to roof access, it is highly likely that the irritant was introduced into the lobby via the HVAC system.

To determine whether airborne irritants from chemicals or fuels were present in the MDC, BEH staff conducted screening for total volatile organic compounds (TVOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. Frequently, exposure to low levels of VOCs may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. In an effort to determine whether VOCs were present, air monitoring was conducted throughout the MDC with a particular focus on the main lobby/security checkpoint. Outdoor background TVOC measurements were taken for comparison to indoor levels. Outdoor TVOC concentrations during the assessment were non-detect (ND) (Table 1). Indoor TVOC concentrations throughout the MDC were also ND at the time of the assessment (Table 1).

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate and acute health effects upon exposure. To determine whether combustion products were present indoors, BEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice

resurfacing equipment. An operator of an indoor ice must take actions to reduce carbon monoxide levels, if those levels exceed 30 ppm, 20 minutes after resurfacing within a rink (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). Carbon monoxide levels measured in the building were also ND during the assessment.

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by

both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 μg/m^3 over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations the day of the assessment were measured at 8 μg/m^3. PM2.5 levels measured in the building ranged from 3 to 28 μg/m^3 (Table 1), which were below the NAAQS PM2.5 level of 35 μg/m^3. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in buildings can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Based on the air measurements conducted at the MDC, no continuing sources of respiratory irritants exist in the building subsequent to the January 16, 2008 incident.

Outer IAQ Concerns

A number of univent return vents and personal fans (Pictures 12 and 19) were observed to have accumulated dust. If univents are not functioning, backdrafting can occur, which can re-aerosolize accumulated dust particles. Re-activated fans can also aerosolize dust accumulated on

fan blades. Finally, open utility holes were observed in the ceiling of the Clerk's storeroom, which can serve as pathways for drafts, dust and debris into occupied areas (Picture 20).

Conclusions/Recommendations

In light of the rapid onset and equally rapid dissipation of irritant symptoms upon ventilating the building coupled with the lack of any historical occurrence of reported symptoms, it appears likely that the incident may have been related to an intentional (or unintentional) discharge of a hand-held irritant (e.g., pepper spray). Therefore, no further actions are recommended with regard to the January 16, 2008 incident. Carbon dioxide levels do indicate a lack of poor air exchange in the building, allowing odors and other indoor environmental pollutants that may be present to persist/build-up and lead to IAQ/comfort complaints.

In view of the findings at the time of the visit, the following general IAQ recommendations are made:

1. Operate both supply and exhaust ventilation *continuously* during periods of occupancy, independent of thermostat control (if possible) to maximize air exchange.
2. Consider increasing the percentage of fresh air supplied to the HVAC system in order to improve indoor air quality.
3. Remove all blockages from univents and return vents to ensure adequate airflow.
4. Contact an HVAC engineering firm for a ventilation systems assessment. Based on the age, physical deterioration and availability of parts for ventilation components, such an evaluation is necessary to determine the operability and feasibility of repairing/replacing the equipment. Determine if univent fans can run independently (i.e., continuous) of

thermostatic controls. If not examine the feasibility of upgrading the control system to provide continuous air exchange.

5. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).

6. Use windows to introduce fresh air and supplement the mechanical ventilation system, particularly in the courtrooms. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding. In addition, occupants should ensure that windows are closed during hot, humid weather to limit moisture intrusion and avoid condensation problems.

7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

8. Ensure leaks are repaired (e.g., April's office/Juvenile Court Magistrate's Office). Remove/replace water-damaged ceiling tiles. Examine the areas above and around for mold growth. Make repairs to damaged wall plaster/peeling paint.

9. Move plants away from univents. Ensure plants are equipped with drip pans made of a non-porous material. Avoid over-watering and examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.

10. Seal around utility pipes in ceiling of Clerk's storeroom (Picture 20).

11. Clean personal fans, univent return vents and general exhaust/return vents periodically of accumulated dust.

12. Consider relocating photocopier or thermostat in Juvenile Court if temperature control is affected.

13. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: http://www.state.ma.us/dph/MDPH/iaq/iaqhome.htm.

References

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Picture 1

Rooftop AHU for Main Lobby/Security Checkpoint Area

Picture 2

AHU located in First Floor Mechanical Room

Picture 3

Supply Diffuser in Main Lobby/Security Checkpoint Area

Picture 4

Return Vent in Main Lobby/Security Checkpoint Area

Picture 5

Slotted Air Diffuser

Picture 6

Louvered Multi-Directional Air Diffuser and Return Grate

Picture 7

Ceiling-Mounted Return Vent

Picture 8

Wall-Mounted Return Vent

Picture 9

Original 1960s Vintage Univent Built into Cabinet

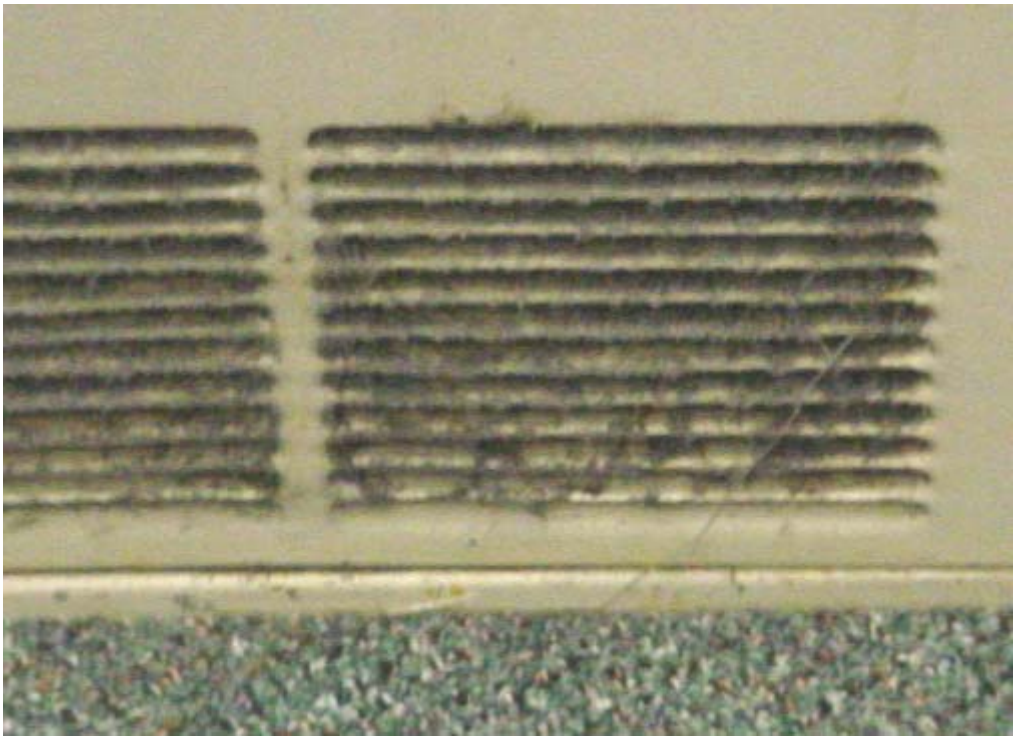
Picture 10

Original 1960s Vintage Free-Standing Univent

Picture 11

Univent Fresh Air Intake

Picture 12



Univent Return Vent, Note Dust/Debris Accumulation

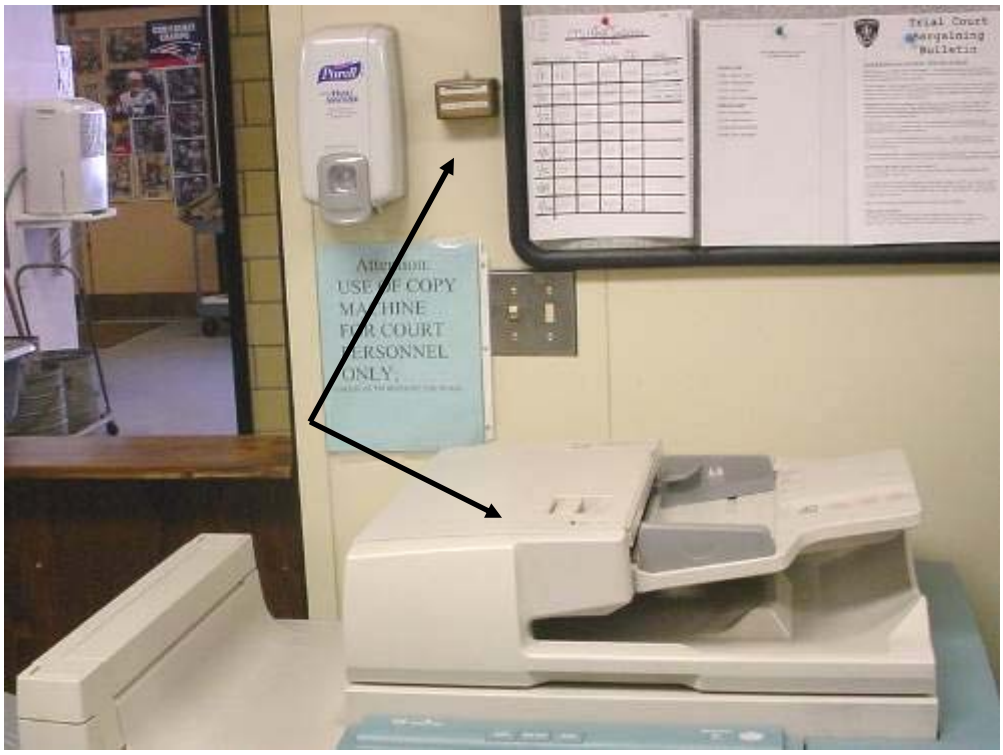
Picture 13

Univent Fan Controls, Note Control in “Off” Position

Picture 14

Vintage 1960s Thermostat for Univent System

Picture 15



Thermostat Directly over Photocopier

Picture 16

Water Damaged Wall Plaster

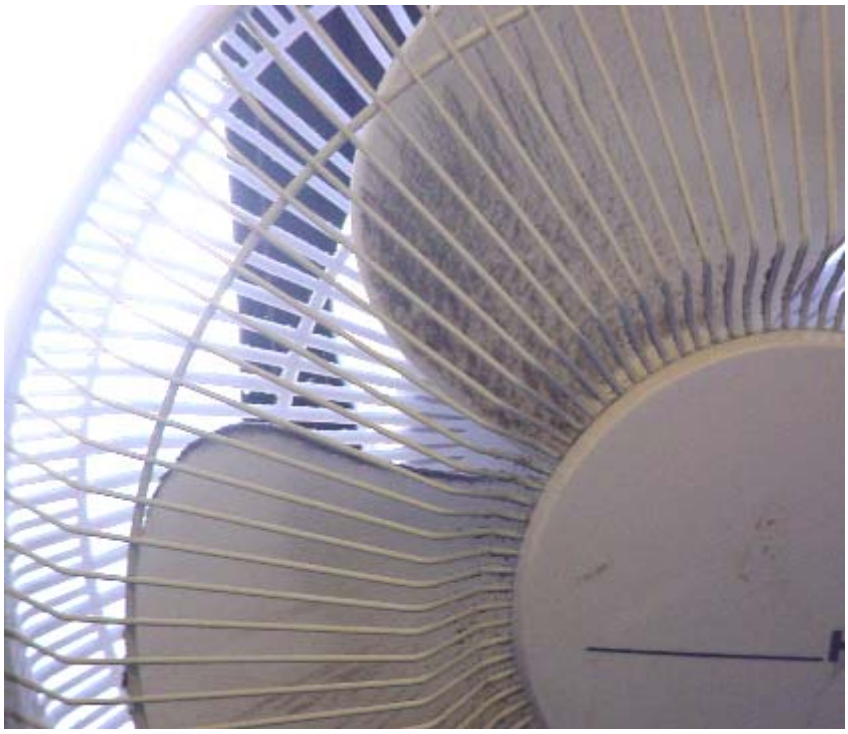
Picture 17

Water Stained Ceiling Tiles in Juvenile Court Magistrate Area

Picture 18

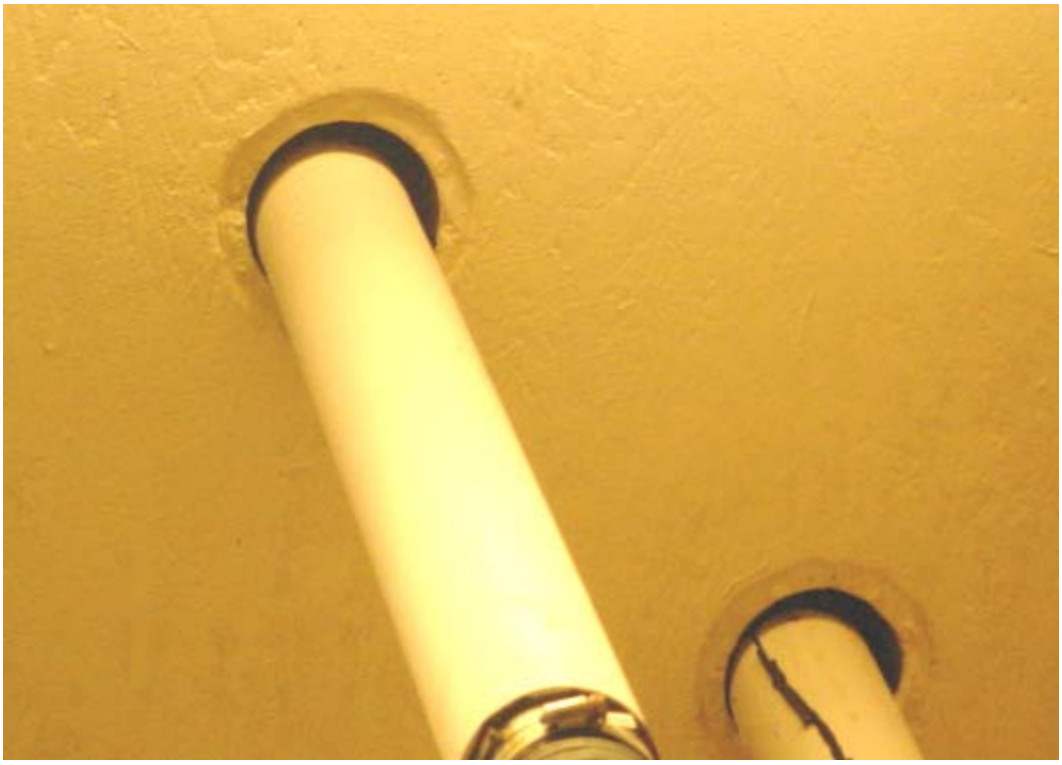
Plant on Paper Towel

Picture 19



Personal Fan with Accumulated Dust and Debris

Picture 20



Open Utility Holes around Pipes in the Clerk's Storeroom

Location: Milford District Court **Indoor Air Results**

Address: 161 West Street, Milford, MA **Table 1** **Date: Jan 18, 2008**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
background		<32	100	348	ND	ND	8				Cold, winds: WSW 6-21 mph (gusts up to 30), moderate to heavy rain in am
Lobby	25	66	57	1370	ND	ND	14	N	Y	Y	
Courtroom #1	30	70	57	3041	ND	ND	28	Y	Y	Y	Windows shut, HVAC system "deactivated"
Courtroom #1 (re-evaluation)	0	71	41	1360 (↓)	ND	ND	16	Y	Y	Y	HVAC system "activated" room empty ~ 15 mins.
Judges Office	0	70	33	666	ND	ND	8	Y	Y	N	UV-off
Judges Lobby	0	71	31	703	ND	ND	12	Y	Y	N	UV-off
Judges Secretary	1	72	31	735	ND	ND	11	Y	Y	N	Plants
Courtroom #2	12	70	35	1300	ND	ND	12	Y	Y	Y	

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
DO = door open
FC = food container
GW = gypsum wallboard
MT = missing ceiling tile
NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WD = water-damaged
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Milford District Court

Address: 161 West Street, Milford, MA

Indoor Air Results

Date: Jan 18, 2008

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Judges chambers	0	71	30	1083	ND	ND	12	Y	Y	N	UV-off
Accounting Office	2	75	37	1413	ND	ND	17	Y	Y	N	1 UV-off, 1 UV-on, dusty return vents
Assistant Clerk	2	78	34	1487	ND	ND	14	Y	Y	N	UV-cycled off, plants on paper towel
Women's Restroom	0	68	31	1067	ND	ND	13	Y	Y Passive door vent	Y	Floor drains
Probation office	4	74	35	1068	ND	ND	13	Y	Y	N	UV-off
April's Office	0	76	31	960	ND	ND	10	Y	Y	N	WD WP & efflorescence-low (i.e., normal) moisture, UV-off
DA's Office	3	75	32	1064	ND	ND	11	Y	Y	Y	low (i.e., normal) moisture
Men's Room	0	74	33	1106	ND	ND	14	Y	Y Passive door vent	Y	

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Indoor Air Results

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Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Clerk Magistrate	0	73	32	1405	ND	ND	12	Y	Y	N	UV-off
Clerk's Office	2	74	34	1604	ND	ND	14	Y	Y	N	
Store/File Room	0	73	33	1700	ND	ND	16	N	N	N	Humidity control device, open utility holes-ceiling
Chief Probation Officer	0	73	29	627	ND	ND	8	Y	Y	N	
Probation Office 1	1	72	28	711	ND	ND	8	Y	Y	N	
Probation Office 2	1	72	30	877	ND	ND	9	Y	Y	N	PF
Juvenile Court	5	75	31	909	ND	ND	9	N	Y	Y	PF, PC under thermostat
Juvenile CT Mag. Office	0	73	29	669	ND	ND	7	N	Y		WD CT 1-in office, 1-outside office, scented candle

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µg/m3 = micrograms per cubic meter

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AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
DO = door open
FC = food container
GW = gypsum wallboard
MT = missing ceiling tile
NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WD = water-damaged
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Milford District Court

Address: 161 West Street, Milford, MA

Indoor Air Results

Date: Jan 18, 2008

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
132	27	70	17	652	ND	ND	7	Y	Y univent	Y ceiling	Univent obstructed by boxes, DEM, accumulated items
133	26	71	20	827	ND	ND	7	Y	Y univent	Y ceiling	Univent obstructed by items, DEM
134 Art	1	73	16	568	ND	ND	5	Y	Y univent	Y ceiling	Plants near univent, cleaners, accumulated items, DEM
135	36	72	17	827	ND	ND	5	Y	Y univent	Y ceiling	DEM
Upper Gym	150	71	13	456	ND	ND	6	N	Y ceiling	Y	4 MT
137	21	69	17	649	ND	ND	3	Y	Y ceiling	Y ceiling	Cleaners, accumulated items, plug-in air freshener

ppm = parts per million
µg/m3 = micrograms per cubic meter

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